INDOOR AIR QUALITY ASSESSMENT

Henry A. Yelle Elementary School
64 West Main Street
Norton, Massachusetts

Prepared by:
Massachusetts Department of Public Health
Center for Environmental Health
Bureau of Environmental Health Assessment
Emergency Response/Indoor Air Quality Program
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Background/Introduction

At the request of parents, the Massachusetts Department of Public Health (MDPH), Center for Environmental Health's (CEH) Bureau of Environmental Health Assessment (BEHA) provided assistance and consultation regarding indoor air quality at the Yelle Elementary School (YES), 64 West Main Street, Norton, Massachusetts. On September 29, 2004, Cory Holmes, an Environmental Analyst in BEHA's Emergency Response/Indoor Air Quality (ER/IAQ) Program, conducted an indoor air quality assessment.

The Yelle Elementary School is a three-story, red brick building with an occupied basement that was constructed in 1950. A one-story addition was built in 1955. Over the years the school has served as both a high school and middle school. The building has a history of roof leaks and water damage. A new roof was installed and drainage was improved over the summer of 2004. New floor tiles and ceiling tiles systems were installed in a number of areas. Windows are openable throughout the building.

Methods

Air tests for carbon dioxide, carbon monoxide, temperature and relative humidity were taken with the TSI, Q-TRAK™ IAQ Monitor, Model 8551. Air tests for airborne particle matter with a diameter less than 2.5 micrometers were taken with the TSI, DUSTTRAK™ Aerosol Monitor Model 8520. Screening for total volatile organic compounds (TVOCs) was conducted using a Thermo Environmental Instruments Inc., Model 580 Series Photo Ionization Detector (PID). BEHA staff also performed a visual inspection of building materials for water damage and/or microbial growth.

Results

The school houses approximately 550 students in grades four and five and approximately 65 staff members. Tests were taken under normal operating conditions and results appear in Table 1.

Discussion

Ventilation

It can be seen from Table 1 that carbon dioxide levels were above 800 parts per million (ppm) parts of air in twenty-six of thirty-eight areas surveyed, indicating inadequate air exchange in the majority of areas surveyed the day of the assessment. These measurements were likely due to the deactivation and/or removal of mechanical ventilation components. Fresh air in classrooms is supplied by a unit ventilator (univent) system (Picture 1). Univents are designed to draw air from outdoors through a fresh air intake located on the exterior walls of the building (Picture 2) and return air through an air intake located at the base of each unit (Figure 1). Fresh and return air are mixed and filtered, then heated and provided to classrooms through an air diffuser located in the top of the unit. Univents are equipped with fan control settings of low, medium or high (Picture 3). None of the univents in the original building were activated, therefore no means of mechanical ventilation was being provided during the assessment.

Obstructions to airflow, such as papers and books stored on univents and bookcases, carts and desks in front of univent returns, were seen in a few classrooms. In order for univents to provide fresh air as designed, units must remain activated and allowed to operate while these rooms are occupied. Intakes must also remain free of obstructions. Lastly, univents are reportedly original equipment, approximately 50-55 years old. Univents of this age can be difficult to maintain because replacement parts are often unavailable.

Exhaust ventilation in classrooms in the original building are provided by a combination of ungrated "cubby" holes located at floor level (Picture 4) and grilles located in the ceilings of coat closets (Picture 5). Air is drawn into the classroom coat closet via undercut closet doors (Picture 6). Exhaust ventilation in the 1955 addition is provided by ducted, grated wall vents powered by rooftop motors (Picture 7). A number of exhaust vents were not operating, indicating that motors were either deactivated or non-functional. School officials reported that several of the exhaust motors were on a repair list and that replacement parts had been ordered. In addition, a number of exhaust vents were obstructed by desks, bookcases and other items (Pictures 4, 5 and 7). As with the univents, in order to function properly, exhaust vents must be activated and remain free of obstructions.

A number of areas throughout the building (cafeteria, gymnasium, music room) were designed to be ventilated by air handling units (AHUs). The unit in the music room was not operating, but rather sealed with fiberglass insulation and appeared to have been deactivated for some time (Pictures 8 and 9). Portions of the mechanical ventilation system in both the cafeteria and gymnasium have been removed. The cafeteria currently has no mechanical ventilation but relies solely on openable windows for air exchange.

To maximize air exchange, the BEHA recommends that both supply and exhaust ventilation operate continuously during periods of school occupancy. In order to have proper ventilation with a univent and exhaust system, the systems must be balanced to provide an adequate amount of fresh air to the interior of a room while removing stale air from the room. It is recommended that existing ventilation systems be re-balanced every five years to ensure adequate air systems function (SMACNA, 1994). The date of the last balancing of these systems was not available at the time of the assessment. Please note that many components of the mechanical ventilation system cannot be balanced in their current condition.

The Massachusetts Building Code requires that each room have a minimum ventilation rate of 15 cubic feet per minute (cfm) per occupant of fresh outside air or openable windows (SBBRS, 1997; BOCA, 1993). The ventilation must be on at all times that the room is occupied. Providing adequate fresh air ventilation with open windows and maintaining the temperature in the comfort range during the cold weather season is impractical. Mechanical ventilation is usually required to provide adequate fresh air ventilation.

Carbon dioxide is not a problem in and of itself. It is used as an indicator of the adequacy of the fresh air ventilation. As carbon dioxide levels rise, it indicates that the ventilating system is malfunctioning or the design occupancy of the room is being exceeded. When this happens a buildup of common indoor air pollutants can occur, leading to discomfort or health complaints. The Occupational Safety and Health Administration (OSHA) standard for carbon dioxide is 5,000 parts per million parts of air (ppm). Workers may be exposed to this level for 40 hours/week, based on a time-weighted average (OSHA, 1997).

The MDPH uses a guideline of 800 ppm for publicly occupied buildings. A guideline of 600 ppm or less is preferred in schools because a majority of occupants is young and considered a more sensitive population in the evaluation of environmental health status. Inadequate ventilation and/or elevated temperatures are major causes of complaints such as respiratory, eye, nose and throat irritation, lethargy and headaches. For more information on carbon dioxide see Appendix A.

Temperature readings ranged from 67° F to 75 ° F, which were below or near the lower end of the BEHA recommended comfort guidelines during the assessment. The BEHA recommends that indoor air temperatures be maintained in a range of 70 ° F to 78 ° F in order to provide for the comfort of building occupants. Temperature complaints were expressed in a number of areas. In many cases concerning indoor air quality, fluctuations of temperature in occupied spaces are typically experienced, even in a building with an adequate fresh air supply. In addition, it is difficult to control temperature and maintain comfort without operating the ventilation equipment as designed (e.g., univents not activated, AHUs removed, exhaust vents obstructed/deactivated).

The relative humidity ranged from 54 to 68 percent, which was above the BEHA recommended comfort range in several areas. The BEHA recommends a comfort range of 40 to 60 percent for indoor air relative humidity. Relative humidity in excess of 70 percent for extended periods of time can provide an environment for mold and fungal growth (ASHRAE, 1989). Relative humidity would be expected to drop below comfort levels during the heating season. The sensation of dryness and irritation is common in a low relative humidity environment. Low relative humidity is a very common problem during the heating season in the northeast part of the United States.

Microbial/Moisture Concerns

The 1955 addition has a ceiling that consists of sheet-metal panels. Several of these panels had dark staining that appeared to be mold growth (Table 1/Picture 10). Potential mold growth was also observed on the surface of wood molding in the music room. Since the sheet-metal and molding are non-porous surfaces, BEHA staff recommended cleaning the surface mold with bleach and water and/or using a high efficiency particulate arrestance (HEPA) equipped vacuum with a brush attachment.

Plants were noted in several classrooms. Plants can be a source of pollen and mold, which can be respiratory irritants for some individuals. Plants should be properly maintained and equipped with drip pans. Plants should also be located away from univents to prevent the aerosolization of dirt, pollen or mold.

Several potential pathways for moisture to enter the building were identified. BEHA staff observed open utility holes in exterior walls (Picture 11) and large cracks in the cement foundation (Pictures 12 and 13). Repeated water penetration can result in the chronic wetting of building materials and potentially lead to microbial growth. In addition, these large cracks/holes in the exterior wall may provide a means of egress for pests/rodents into the building.

The US Environmental Protection Agency (US EPA) and the American Conference of Governmental Industrial Hygienists (ACGIH) recommends that porous materials be dried with fans and heating within 24 to 48 hours of becoming wet (US EPA, 2001; ACGIH, 1989). If porous materials are not dried within this time frame, mold growth may occur. Water-damaged porous materials cannot be adequately cleaned to remove mold growth. The application of a mildewcide to moldy porous materials is not recommended.

Other Concerns

Indoor air quality can be adversely impacted by the presence of respiratory irritants, such as products of combustion. The process of combustion produces a number of pollutants. Common combustion products include carbon monoxide, carbon dioxide, water vapor and smoke (fine airborne particle material). Of these materials, exposure to carbon monoxide and particulate matter with a diameter of 2.5 micrometers (μm) or less (PM2.5) can produce immediate, acute health effects upon exposure. To determine whether combustion products were present in the school environment, BEHA staff obtained measurements for carbon monoxide and PM2.5.

Carbon monoxide is a by-product of incomplete combustion of organic matter (e.g., gasoline, wood and tobacco). Exposure to carbon monoxide can produce immediate and acute health affects. Several air quality standards have been established to address carbon monoxide pollution and prevent symptoms from exposure to these substances. The MDPH established a corrective action level concerning carbon monoxide in ice skating rinks that use fossil-fueled ice resurfacing equipment. If an operator of an indoor ice rink measures a carbon monoxide level over 30 ppm, taken 20 minutes after resurfacing within a rink, that operator must take actions to reduce carbon monoxide levels (MDPH, 1997).

ASHRAE has adopted the National Ambient Air Quality Standards (NAAQS) as one set of criteria for assessing indoor air quality and monitoring of fresh air introduced by HVAC systems (ASHRAE, 1989). The NAAQS are standards established by the US EPA to protect the public health from six criteria pollutants, including carbon monoxide and particulate matter (US EPA, 2000a). As recommended by ASHRAE, pollutant levels of fresh air introduced to a building should not exceed the NAAQS (ASHRAE, 1989). The NAAQS were adopted by reference in the Building Officials & Code Administrators (BOCA) National Mechanical Code of 1993 (BOCA, 1993), which is now an HVAC standard included in the Massachusetts State Building Code (SBBRS, 1997). According to the NAAQS established by the US EPA, carbon monoxide levels in outdoor air should not exceed 9 ppm in an eight-hour average (US EPA, 2000a).

Carbon monoxide should not be present in a typical, indoor environment. If it *is* present, indoor carbon monoxide levels should be less than or equal to outdoor levels. Outdoor carbon monoxide concentrations were non-detect or ND. Carbon monoxide levels measured in the school were also ND (Table 1).

The US EPA has also established NAAQS limits for exposure to particulate matter. Particulate matter is airborne solids that can be irritating to the eyes, nose and throat. The NAAQS originally established exposure limits for particulate matter with a diameter of 10 μm or less (PM10). According to the NAAQS, PM10 levels should not exceed 150 micrograms per cubic meter ($\mu g/m^3$) in a 24-hour average (US EPA, 2000a). This standard was adopted by both ASHRAE and BOCA. Since the issuance of the ASHRAE standard and BOCA Code, US EPA proposed a more protective standard for fine airborne particles. This more stringent, PM2.5 standard requires outdoor air particulate levels be maintained below 65 $\mu g/m^3$ over a 24-hour average (US EPA, 2000a). Although both the ASHRAE standard and BOCA Code adopted the PM10 standard for evaluating air quality, BEHA uses the more protective proposed PM2.5 standard for evaluating airborne particulate matter concentrations in the indoor environment.

Outdoor PM2.5 concentrations were measured at 7 $\mu g/m^3$ (Table 1). PM2.5 levels measured indoors ranged from 9 to 38 $\mu g/m^3$ (Table 1). Although PM2.5 measurements were above background in some areas, they were below the NAAQS of 65 $\mu g/m^3$. Frequently, indoor air levels of particulates (including PM2.5) can be at higher levels than those measured outdoors. A number of mechanical devices and/or activities that occur in schools can generate particulate during normal operations. Sources of indoor airborne particulates may include but are not limited to particles generated during the operation of fan belts in the HVAC system, cooking in the cafeteria stoves and microwave ovens; use of photocopiers, fax machines and computer printing devices; operation of an ordinary vacuum cleaner and heavy foot traffic indoors.

Indoor air quality can also be impacted by the presence of materials containing volatile organic compounds (VOCs). VOCs are substances that have the ability to evaporate at room temperature. Frequently, exposure to low levels of total VOCs (TVOCs) may produce eye, nose, throat and/or respiratory irritation in some sensitive individuals. For example, chemicals evaporating from a paint can stored at room temperature would most likely contain VOCs. In an effort to determine whether VOCs were present in the building, air monitoring for TVOCs was conducted. Outdoor air samples were taken for comparison. Outdoor TVOC concentrations were ND. Indoor TVOC measurements throughout the building were also ND (Table 1).

Please note, that the TVOC air measurements are only reflective of the indoor air concentrations present at the time of sampling. Indoor air concentrations can be greatly impacted by the use of TVOC containing products. While no measurable TVOC levels were detected in the indoor environment, VOC-containing materials were noted. Cleaning products were found on countertops and beneath sinks in a number of classrooms. Cleaning products contain VOCs and other chemicals, which can be irritating to the eyes, nose and throat and should be stored properly and kept out of reach of students.

Several areas contain photocopiers and lamination machines. Lamination machines can produce irritating odors during use. VOCs and ozone can be produced by photocopiers, particularly if the equipment is older and in frequent use. Ozone is a respiratory irritant (Schmidt Etkin, 1992). These areas are not equipped with local exhaust ventilation to help reduce excess heat and odors.

Several other conditions that can affect indoor air quality were noted during the assessment. Univents in the original building had accumulated dust, cobwebs and debris within the air handling chambers and on filters. Several window-mounted air conditioners (ACs) were installed in classrooms. These units are also normally equipped with filters, which should be cleaned or changed as per the manufacturer's instructions. BEHA staff removed the covers of several ACs to examine the interior of the units and found no filter media installed and the cooling fins occluded with dust and debris (Picture 14). In order to prevent the equipment from serving as a source of aerosolized particulates, BEHA staff recommended changing/installing filters and cleaning the air handling sections of the univents and AC's *prior to re-activation*.

A number of exhaust vents in classrooms and restrooms also had accumulated dust (Picture 15). If exhaust vents are not functioning, backdrafting can occur, which can re-aerosolize dust particles. In addition, these materials can accumulate on flat surfaces (e.g., desktops, shelving and carpets) in occupied areas and subsequently be re-aerosolized causing further irritation. Dust can be irritating to eyes, nose and respiratory tract.

Also of note was the amount of materials stored inside classrooms. In classrooms throughout the school, items were observed on windowsills, tabletops, counters, bookcases and desks. The large number of items stored in classrooms provides a source for dusts to accumulate. These items (e.g., papers, folders, boxes) make it difficult for custodial staff to clean. Items should be relocated and/or be cleaned periodically to avoid excessive dust build up.

In an effort to reduce noise from sliding chairs, tennis balls had been sliced open and placed on chair legs (Picture 16). Tennis balls are made of a number of materials that are a source of respiratory irritants. Constant wearing of tennis balls can produce fibers and cause TVOCs to off-gas. Tennis balls are made with a natural rubber latex bladder, which becomes abraded when used as a chair leg pad. Use of tennis balls in this manner may introduce latex dust into the school environment. Some individuals are highly allergic to latex (e.g., spina bifida patients) (SBAA, 2001). It is recommended that the use of materials containing latex be limited in buildings to reduce the likelihood of symptoms in sensitive individuals (NIOSH, 1997). A question and answer sheet concerning latex allergy is attached as Appendix B (NIOSH, 1998). In many areas, alternative "glides" are used on chair legs (Picture 17), school officials reported that more of these glides are on order to replace tennis balls.

Finally, during a perimeter inspection of the building, BEHA staff observed several bees/wasps nests on the exterior of the building. Under current Massachusetts law (effective November 1, 2001) the principles of integrated pest management (IPM) must be used to remove pests in state buildings (Mass Act, 2000). Pesticide use indoors can introduce chemicals into the indoor environment that can be sources of eye, nose and throat irritation. School officials reported that they are contracting with an extermination firm to remove nests.

Conclusions/Recommendations

The conditions related to indoor air quality problems at the Yelle Elementary School raise a number of issues. The general building conditions, maintenance, work hygiene practices and the condition of HVAC equipment, if considered individually, present conditions that could degrade indoor air quality. When combined, these conditions can serve to further degrade indoor air quality. Some of these conditions can be remedied by actions of building occupants. Other remediation efforts will require alteration to the building structure and equipment. For these reasons, a two-phase approach is required for remediation. The first consists of **short-term** measures to improve air quality and the second consists of **long-term** measures that will require planning and resources to adequately address the overall indoor air quality concerns.

The following **short-term** measures should be considered for immediate implementation:

1. Examine each univent for function. Survey classrooms for univent function to ascertain if an adequate air supply exists for each room. Consider consulting a heating, ventilation and air conditioning (HVAC) engineer concerning the calibration of univent fresh air control dampers throughout the school.
2. Operate all ventilation systems that are operable throughout the building continuously during periods of school occupancy and independent of thermostat control. To increase airflow in classrooms, set univent controls to "high".
3. Inspect exhaust motors and belts for proper function. Continue with plans to repair and replace as necessary.
4. Remove all blockages from univents and exhaust vents to ensure adequate airflow.
5. Consider having ventilation systems re-balanced every five years by an HVAC engineering firm.
6. For buildings in New England, periods of low relative humidity during the winter are often unavoidable. Therefore, scrupulous cleaning practices should be adopted to minimize common indoor air contaminants whose irritant effects can be enhanced when the relative humidity is low. To control for dusts, a high efficiency particulate arrestance (HEPA) filter equipped vacuum cleaner in conjunction with wet wiping of all surfaces is recommended. Avoid the use of feather dusters. Drinking water during the day can help ease some symptoms associated with a dry environment (throat and sinus irritations).

7. Ensure roof leaks are repaired and repair/replace any remaining water-stained ceiling tiles and/or plaster.
8. Clean mold growth on the surface of metal ceiling panels with bleach and water and/or using a HEPA vacuum with a brush attachment. Examine areas above these tiles for microbial growth. Disinfect with an appropriate antimicrobial where necessary.
9. Seal utility holes on exterior of building with a foam insulation material.
10. Repair cracks/breaches in foundation to prevent water penetration, drafts and pest entry.
11. Move plants away from univents in classrooms. Avoid over-watering and examine drip pans periodically for mold growth. Disinfect with an appropriate antimicrobial where necessary.
12. Change filters for air-handling equipment (e.g., univents, AHUs and ACs) as per the manufacturer's instructions or more frequently if needed. Vacuum interior of units prior to activation to prevent the aerosolization of dirt, dust and particulates. Ensure filters fit flush in their racks with no spaces in between allowing bypass of unfiltered air into the unit.
13. Clean univent return vents and exhaust vents periodically of accumulated dust.
14. Relocate or consider reducing the amount of materials stored in classrooms to allow for more thorough cleaning. Clean items regularly with a wet cloth or sponge to prevent excessive dust build-up.
15. Store cleaning products properly and out of reach of students.
16. Use the principles of integrated pest management (IPM) to rid the building of pests. A copy of the IPM recommendations can be obtained from the Massachusetts Department of Food and Agriculture (MDFA) website at the following website: http://www.state.ma.us/dfa/pesticides/publications/IPM_kit_for_bldg_mgrs.pdf.

17. Continue with plans to replace tennis balls on chair legs with alternative “glides”, as illustrated in Picture 17, to prevent latex dust generation.
18. Consider developing a written notification system for building occupants to report indoor air quality issues/problems. Have these concerns relayed to the maintenance department/ building management in a manner that allows for a timely remediation of the problem.
19. Consult “Mold Remediation in Schools and Commercial Buildings” published by the US EPA (US EPA, 2001) for further information on mold and/or mold clean up. Copies of this document are available from the US EPA at: http://www.epa.gov/iaq/molds/mold_remediation.html.
20. Consider adopting the US EPA (2000b) document, “Tools for Schools”, to maintain a good indoor air quality environment on the building. This document can be downloaded from the Internet at: http://www.epa.gov/iaq/schools/index.html.
21. Refer to resource manuals and other related indoor air quality documents for further building-wide evaluations and advice on maintaining public buildings. These materials are located on the MDPH’s website at http://www.state.ma.us/dph/beha/iaq/iaqhome.htm.

The following **long-term measures** should be considered:

1. Contact an HVAC engineering firm for an assessment of the ventilation system’s control system (e.g., controls, air intake louvers, thermostats). Based on the age, physical deterioration and availability of parts for ventilation components, such an evaluation is necessary to determine the operability and feasibility of repairing/replacing the equipment.
2. Consider providing local exhaust ventilation for photocopiers in the copy room.

References

ACGIH. 1989. Guidelines for the Assessment of Bioaerosols in the Indoor Environment. Code Administrators International, Inc., Country Club Hill, IL.

ASHRAE. 1989. Ventilation for Acceptable Indoor Air Quality. American Society of Heating, Refrigeration and Air Conditioning Engineers. ANSI/ASHRAE 62-1989

BOCA. 1993. The BOCA National Mechanical Code/1993. 8th ed. Building Officials and Code Administrators International, Inc., Country Club Hill, IL. Section M-308.1.1.

Mass. Act. 2000. An Act Protecting Children and families from Harmful Pesticides. 2000 Mass Acts c. 85 sec. 6E.

MDPH. 1997. Requirements to Maintain Air Quality in Indoor Skating Rinks (State Sanitary Code, Chapter XI). 105 CMR 675.000. Massachusetts Department of Public Health, Boston, MA.

NIOSH. 1997. NIOSH Alert Preventing Allergic Reactions to Natural Rubber latex in the Workplace. National Institute for Occupational Safety and Health, Atlanta, GA.

NIOSH. 1998. Latex Allergy A Prevention. National Institute for Occupational Safety and Health, Atlanta, GA.

OSHA. 1997. Limits for Air Contaminants. Occupational Safety and Health Administration. Code of Federal Regulations. 29 C.F.R 1910.1000 Table Z-1-A.

SBAA. 2001. Latex In the Home And Community Updated Spring 2001. Spina Bifida Association of America, Washington, DC.

SBBRS. 1997. Mechanical Ventilation. State Board of Building Regulations and Standards. Code of Massachusetts Regulations. 780 CMR 1209.0

Schmidt Etkin, D. 1992. Office Furnishings/Equipment & IAQ Health Impacts, Prevention & Mitigation. Cutter Information Corporation, Indoor Air Quality Update, Arlington, MA.

SMACNA. 1994. HVAC Systems Commissioning Manual. 1st ed. Sheet Metal and Air Conditioning Contractors' National Association, Inc., Chantilly, VA.

US EPA. 2000a. National Ambient Air Quality Standards (NAAQS). . US Environmental Protection Agency, Office of Air Quality Planning and Standards, Washington, DC. http://www.epa.gov/air/criteria.html.

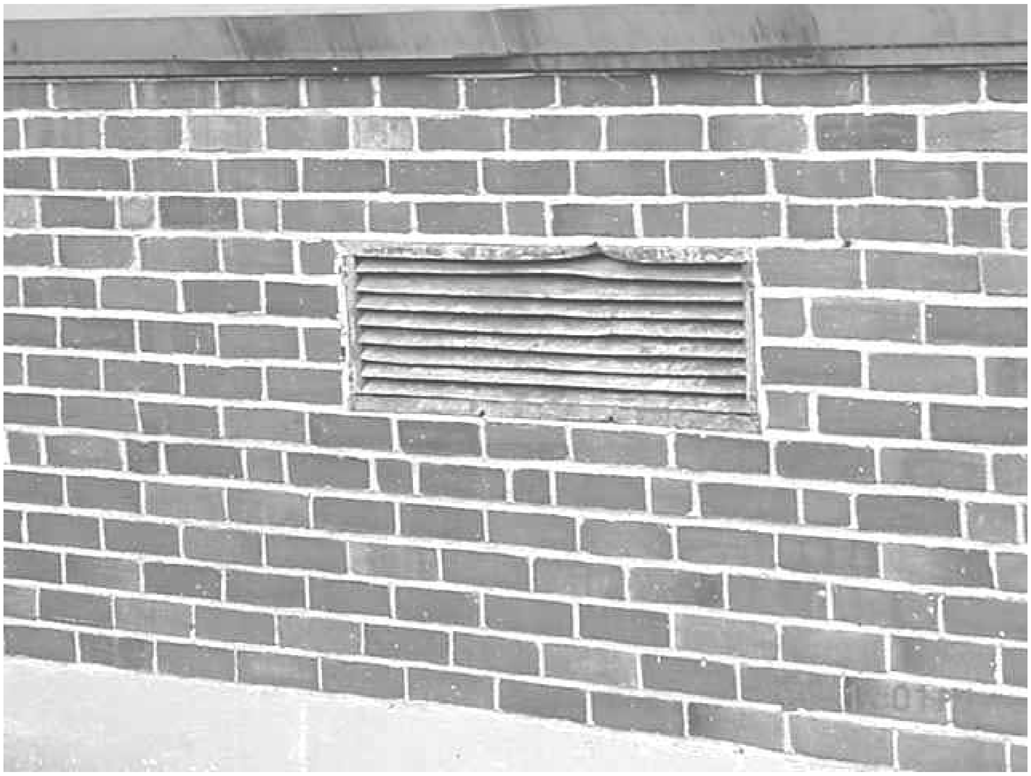
US EPA. 2000b. Tools for Schools. Office of Air and Radiation, Office of Radiation and Indoor Air, Indoor Environments Division (6609J). EPA 402-K-95-001, Second Edition. http://www.epa.gov/iaq/schools/tools4s2.html

US EPA. 2001. Mold Remediation in Schools and Commercial Buildings. US Environmental Protection Agency, Office of Air and Radiation, Indoor Environments Division, Washington, D.C. EPA 402-K-01-001. March 2001.

Picture 1

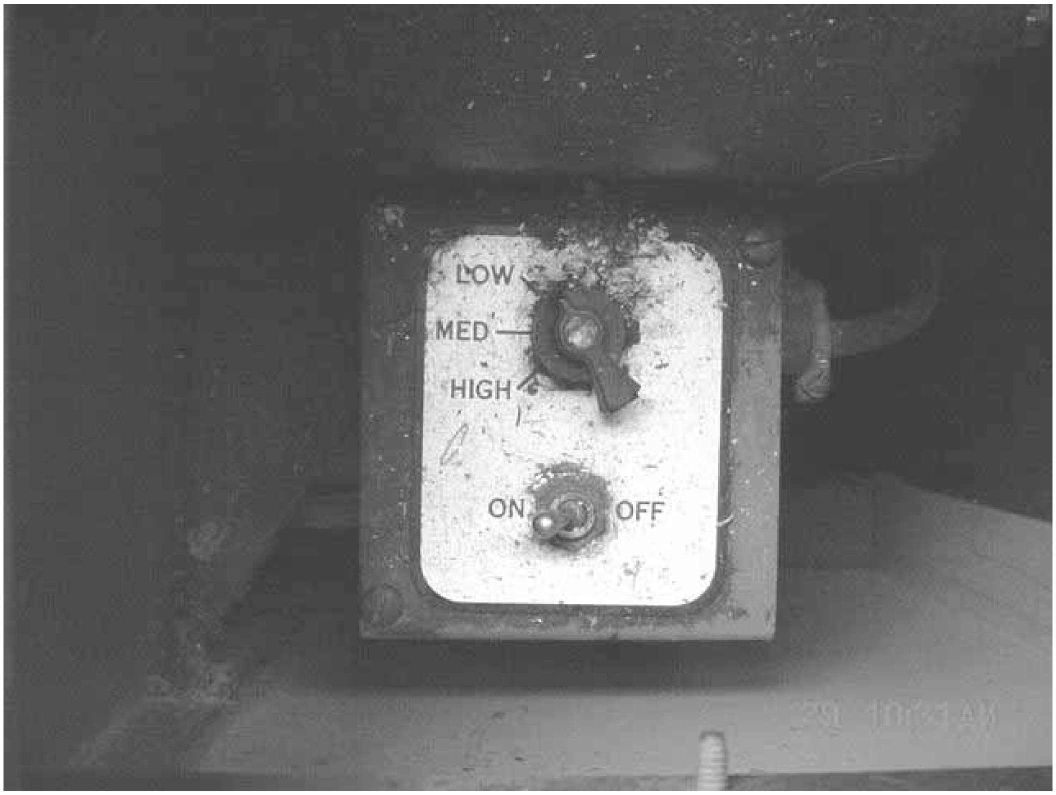
Classroom Univent 1950's Vintage

Picture 2



Univent Air Intake

Picture 3



Univent Controls

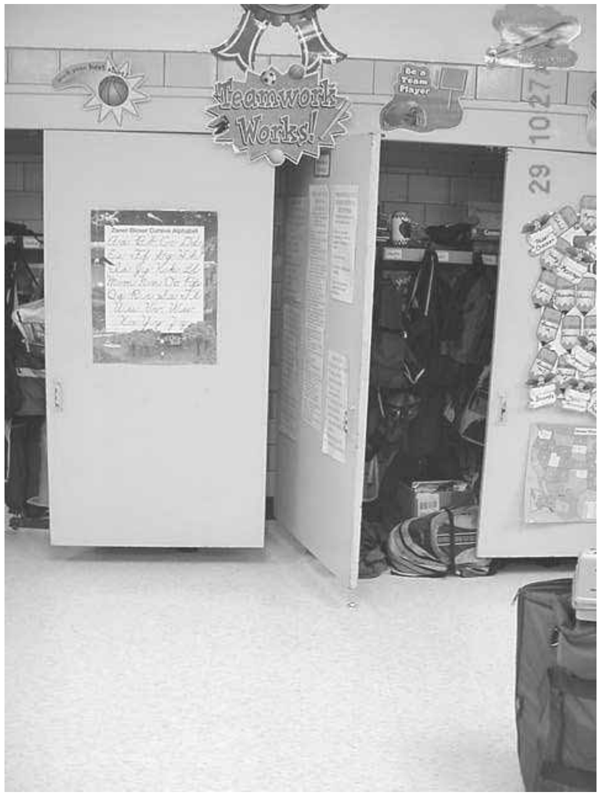
Picture 4

“Cubby-Hole” Exhaust Vent, Note Stored Materials Within

Picture 5

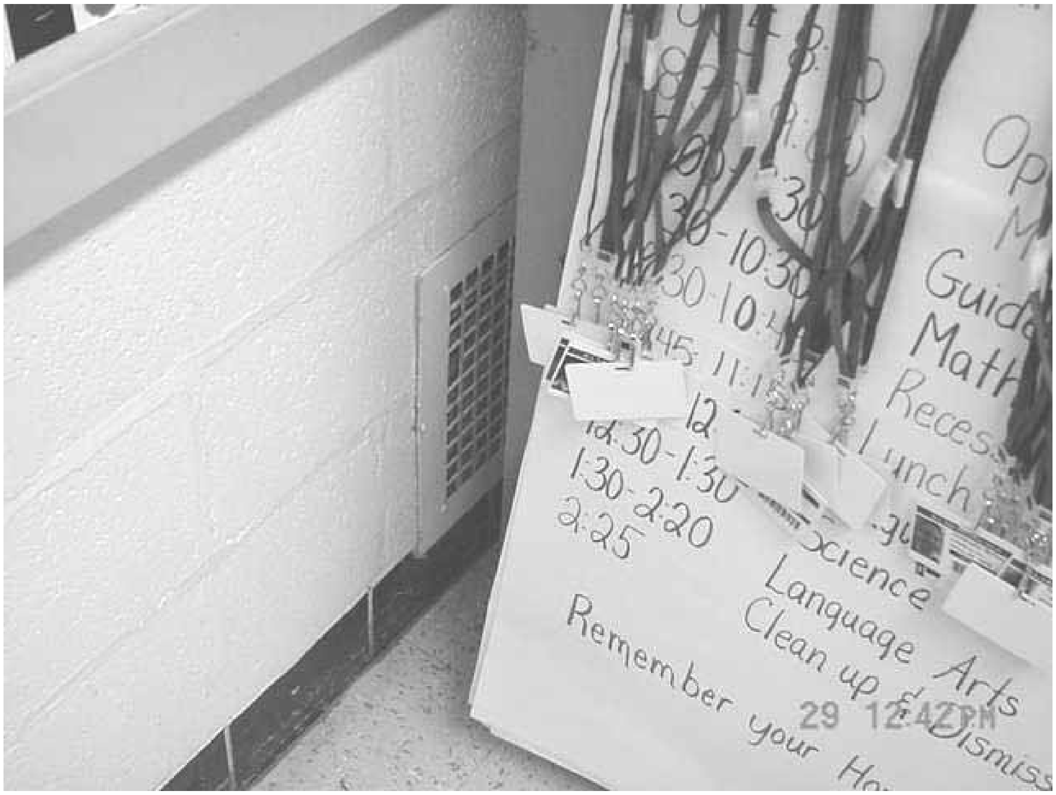
Coat Closet Exhaust Vent, Note Stored Materials

Picture 6



Undercut Coat Closet Doors

Picture 7



Partially Obstructed Exhaust Vent

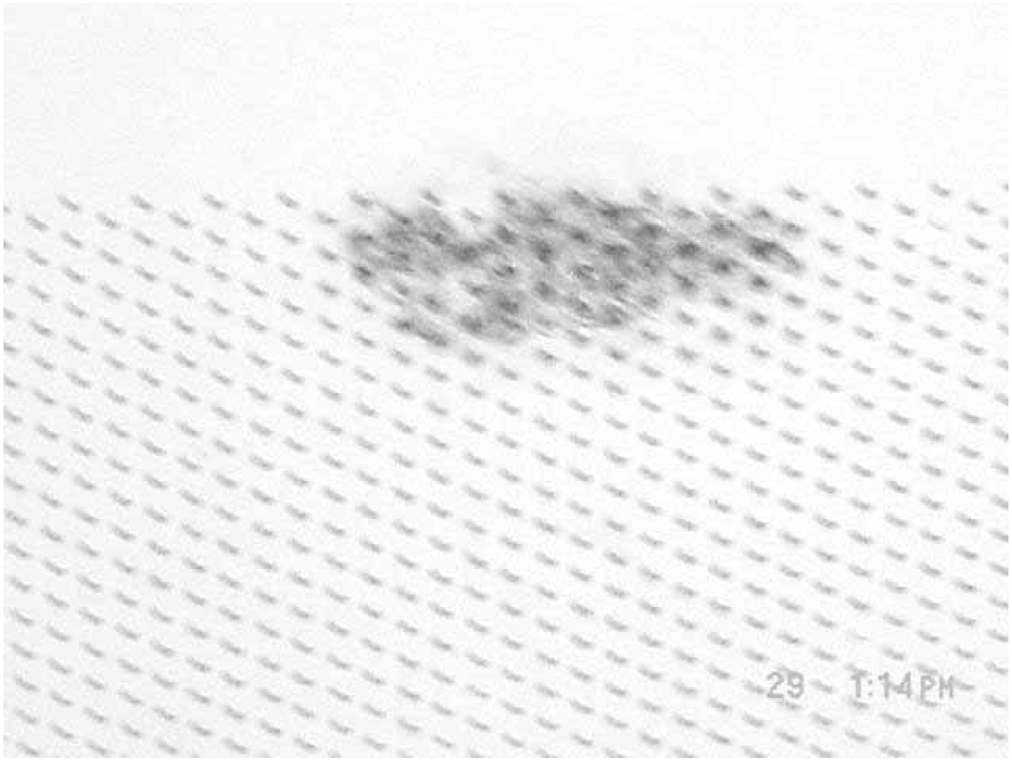
Picture 8

Deactivated AHU in Music Room

Picture 9

Close-up of Supply Vent Stuffed with Fiberglass Insulation in Music Room

Picture 10



Dark Stain (Possible Mold Growth) on Metal Ceiling Panels in 1955 Addition

Picture 11

Open Utility Hole in Exterior Brick

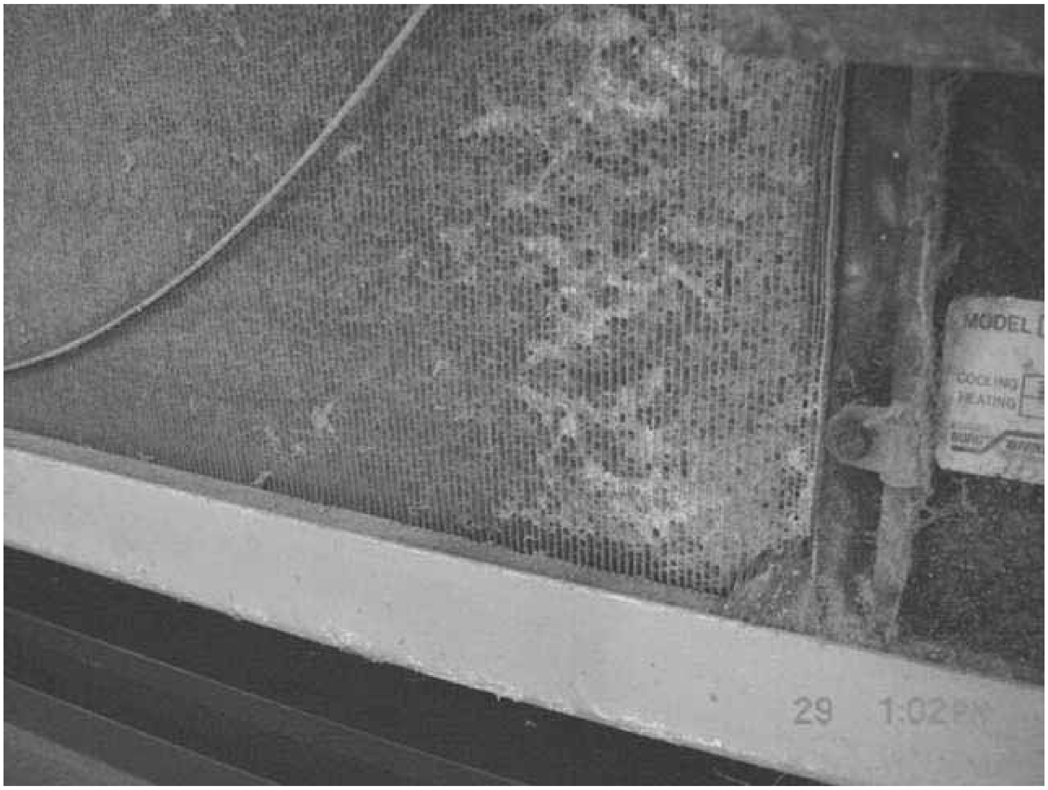
Picture 12

Large Crack/Breach (Above Windows) in Foundation Cement

Picture 13

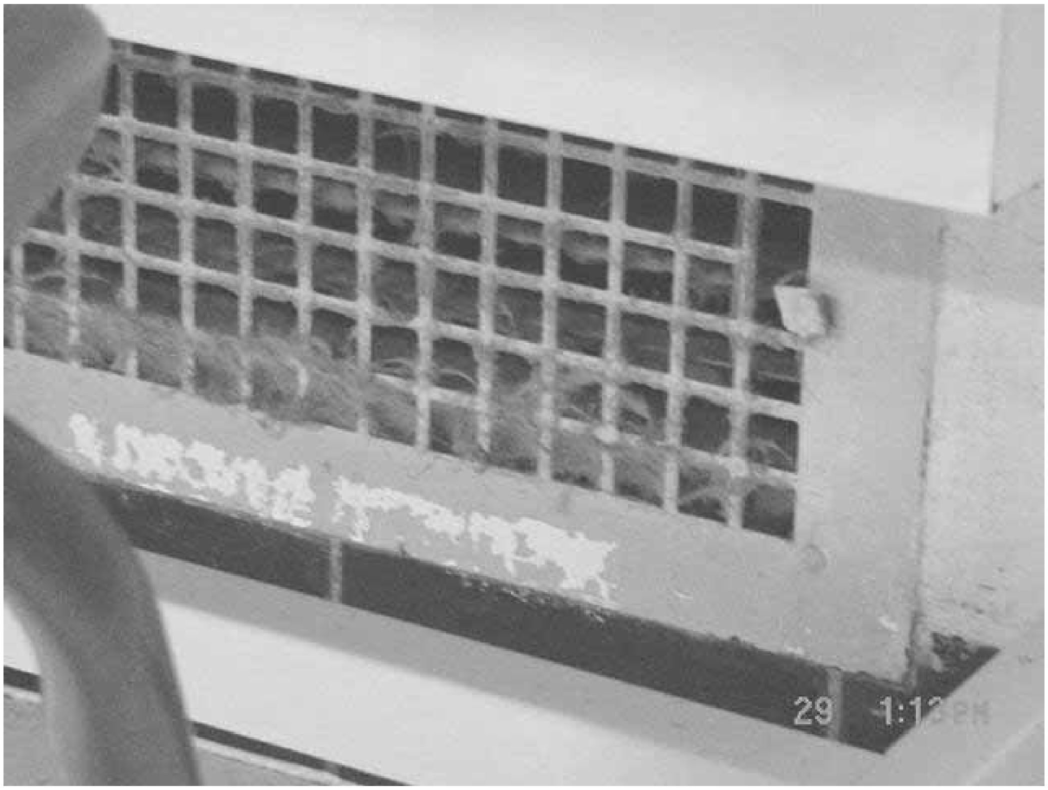
Large Crack/Breach (Above Windows) in Foundation Cement

Picture 14



Dust and Debris in Cooling Fins of Classroom AC with no Filter Media Installed

Picture 15



Dirt/Dust Build-Up in Classroom Exhaust Vent

Picture 16

Tennis Balls on Chair Legs

Picture 17

"Glides" on Bottom of Chair Legs

Yelle Elementary School **Indoor Air Results**

64 West Main Street, Burlington, MA **September 29, 2004**

Table 1

Location/ Room	Temp (°F)	Relative Humidity (%)	Carbon Dioxide (*ppm)	Carbon Monoxide (*ppm)	TVOCs (*ppm)	PM2.5 (µg/m3)	Occupants in Room	Windows Openable	Ventilation		Remarks
									Supply	Exhaust	
Background (outdoors)	60	69	328	ND	ND	7		-	-	-	Atmospheric Conditions: NE wind 15-20 MPH, heavy rain
1	73	68	2079	ND	ND	28	17	Y	Y	Y	DEM, TB, UV off
2	71	64	1761	ND	ND	38	21	Y	Y	Y	DEM, TB, UV off
3	73	60	1318	ND	ND	26	8	Y	Y	Y	UV off
4	73	56	975	ND	ND	17	37	Y	Y	Y	DEM, TB, PF, abandoned chem. emer shower/eye wash station, UV off
5	72	55	783	ND	ND	12	0	Y	Y	Y	DEM, plants, UV off
6	71	59	1131	ND	ND	19	0	Y	Y	Y	DO, DEM, UV interior-dirt/dust, filter dirty, UV off

ppm = parts per million parts of air
CT = ceiling tile
AD = air deodorizer
AP = air purifier
CD = chalk dust

µg/m3 = microgram per cubic meter
WD = water damage
DEM = dry erase marker
DO = door open
PC = photocopier

UV = univent
CF = ceiling fan
PF = personal fan
TB = tennis balls
UF = upholstered furniture

Comfort Guidelines

Carbon Dioxide -	< 600 ppm = preferred
	600 - 800 ppm = acceptable
	> 800 ppm = indicative of ventilation problems
Temperature -	70 - 78 °F
Relative Humidity -	40 - 60%

Yelle Elementary School

64 West Main Street, Burlington, MA

Table 1

Indoor Air Results

September 29, 2004

Location/ Room	Temp (°F)	Relative Humidity (%)	Carbon Dioxide (*ppm)	Carbon Monoxide (*ppm)	TVOCs (*ppm)	PM2.5 (µg/m3)	Occupants in Room	Windows Openable	Ventilation Supply	Ventilation Exhaust	Remarks
3rd Floor Copy Rm	73	58	891	ND	ND	24	0	Y	N	N	PC
7	73	57	938	ND	ND	20	1	Y	Y	Y	PF, DEM, UV off, PF, UV off
8	70	54	592	ND	ND	13	0	Y	Y	Y	DO, 2 windows open, UV off, DEM, PF, UV off
9	75	63	1427	ND	ND	17	23	Y	Y	Y	Plug-in air fresheners, DEM, PF, DO, UV off
11	72	54	915	ND	ND	14	27	Y	Y	Y	DO, 2 windows open, UV off, DEM, PF, UV off, PF dusty
12	72	58	1020	ND	ND	14	0	Y	Y	Y	DEM, UV off
13	73	58	1220	ND	ND	17	8	Y	Y	Y	DEM, PF, TB, UV off

ppm = parts per million parts of air
CT = ceiling tile
AD = air deodorizer
AP = air purifier
CD = chalk dust

µg/m3 = microgram per cubic meter
WD = water damage
DEM = dry erase marker
DO = door open
PC = photocopier

UV = univent
CF = ceiling fan
PF = personal fan
TB = tennis balls
UF = upholstered furniture

Comfort Guidelines

Carbon Dioxide -	< 600 ppm = preferred
	600 - 800 ppm = acceptable
	> 800 ppm = indicative of ventilation problems
Temperature -	70 - 78 °F
Relative Humidity -	40 - 60%

Yelle Elementary School **Indoor Air Results**

64 West Main Street, Burlington, MA **Table 1** **September 29, 2004**

Location/ Room	Temp (°F)	Relative Humidity (%)	Carbon Dioxide (*ppm)	Carbon Monoxide (*ppm)	TVOCs (*ppm)	PM2.5 (µg/m3)	Occupants in Room	Windows Openable	Ventilation		Remarks
									Supply	Exhaust	
14	73	62	1668	ND	ND	19	29	Y	Y	Y	Air purifier on floor, PF
15	73	56	1013	ND	ND	15	17	Y	Y	Y	2 windows open, AC-window, DEM, DO
OT/PT	73	56	673	ND	ND	19	1		Y	Y	UV off, DEM
18	72	55	622	ND	ND	20	2	Y	Y	Y	AC window, UV off, cleaners
19	72	60	1144	ND	ND	23	23	Y	Y	Y	UV off/blocked by furniture, DEM, TB
20	71	59	1140	ND	ND	21	26	Y	Y	Y	UV off, exhaust blocked by boxes, clutter & furniture, DEM, TB
23 Music Room	69	64	1420	ND	ND	29	27	N	Y	Y	AHU deactivated-stuffed with fiberglass, musty odors, possible mold growth on wood molding, DEM

ppm = parts per million parts of air
CT = ceiling tile
AD = air deodorizer
AP = air purifier
CD = chalk dust

µg/m3 = microgram per cubic meter
WD = water damage
DEM = dry erase marker
DO = door open
PC = photocopier

UV = univent
CF = ceiling fan
PF = personal fan
TB = tennis balls
UF = upholstered furniture

Comfort Guidelines

Carbon Dioxide -	< 600 ppm = preferred
	600 - 800 ppm = acceptable
	> 800 ppm = indicative of ventilation problems
Temperature -	70 - 78 °F
Relative Humidity -	40 - 60%

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									Supply	Exhaust	
24 Band Room	69	65	547	ND	ND	23	0	Y	Y		DEM, 2 missing CT
Cafeteria	67	59	514	ND	ND	9	26	Y	Y	Y	3 windows open, vents sealed AHUs removed
28 Art	72	64	1527	ND	ND	18	23	Y	Y	Y	UV off, DEM
29	71	59	993	ND	ND	16	10	Y	Y	Y	UV off, DEM, TB
30	70	55	580	ND	ND	12	1	Y	Y	Y	DEM, 24 occupants gone 20 min
32	70	58	777	ND	ND	9	14	Y	Y	Y	DEM, exhaust blocked by furniture
33	70	59	836	ND	ND	10	21	Y	Y	Y	UV obstructed by clutter, exhaust blocked by furniture, DO

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34	71	60	1255	ND	ND	10	26	N	Y	Y	DO, DEM, exhaust blocked by clutter
35	70	56	630	ND	ND	11	22	Y	Y	Y	DO
Guidance	70	58	647	ND	ND	11	3	Y	Y		UV off, obstructed by clutter, AC unit, PC
Library	71	63	906	ND	ND	9	4	Y	Y	N	Lamination machine, no local exhaust
36	70	61	1242	ND	ND	9	22	Y	Y	Y	DEM, PF
37	71	60	1143	ND	ND	9	26	Y	Y	Y	DEM, AC window-drafts, no filter, dirty/dusty
38	70	57	998	ND	ND	10	21	Y	Y	Y	AC dirty/no filter, exhaust vent in bottom of closet, TB

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									Supply	Exhaust	
39	70	62	1374	ND	ND	9	25	Y	Y	Y	Exhaust vent – dusty, obstructed by furniture, Abandoned eye wash station/emergency shower, stained ceiling panel possible mold growth, DEM
40	70	58	1050	ND	ND	10	26	Y	Y	Y	Stained ceiling panels possible mold growth, DEM, PF
42 Computer Room	70	55	495	ND	ND	9	1	Y	Y	Y	DO, DEM, AC-dirty/dusty no filter media
44	70	55	600	ND	ND	11	6	Y	Y	Y	DO

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